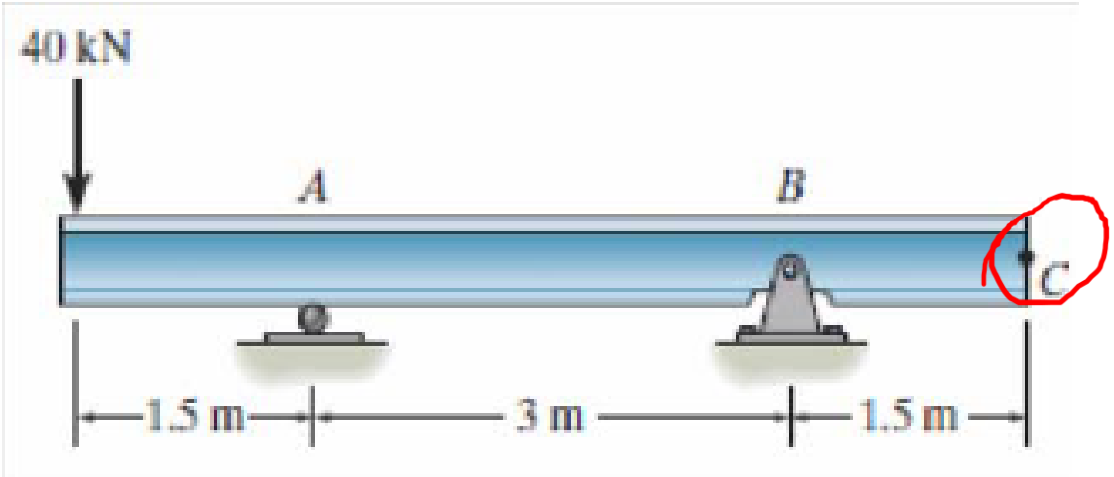
Problem 14-91

Determine the displacement of point C of the beam made from A-36 steel and having a moment of inertia of $I = 21(10^6)\ \text{mm}^4$.

Given: $a := 1.5\text{m}$ $b := 3\text{m}$ $P := 40\text{kN}$

$E := 200\text{GPa}$ $I := 21\left(10^6\right)\text{mm}^4$

Solution: *Virtual Force* $F' := 1\text{kN}$ ↓



Solution to 14-91

$+\uparrow \sum F_y = 0 \quad A - B - P = 0 \quad (1)$

$(+ \sum M_B = 0 \quad A \cdot b - P(a+b) = 0 \quad (2)$

$A = \frac{P(a+b)}{b} = 60\,kN \qquad B = P - A = -20\,kN$

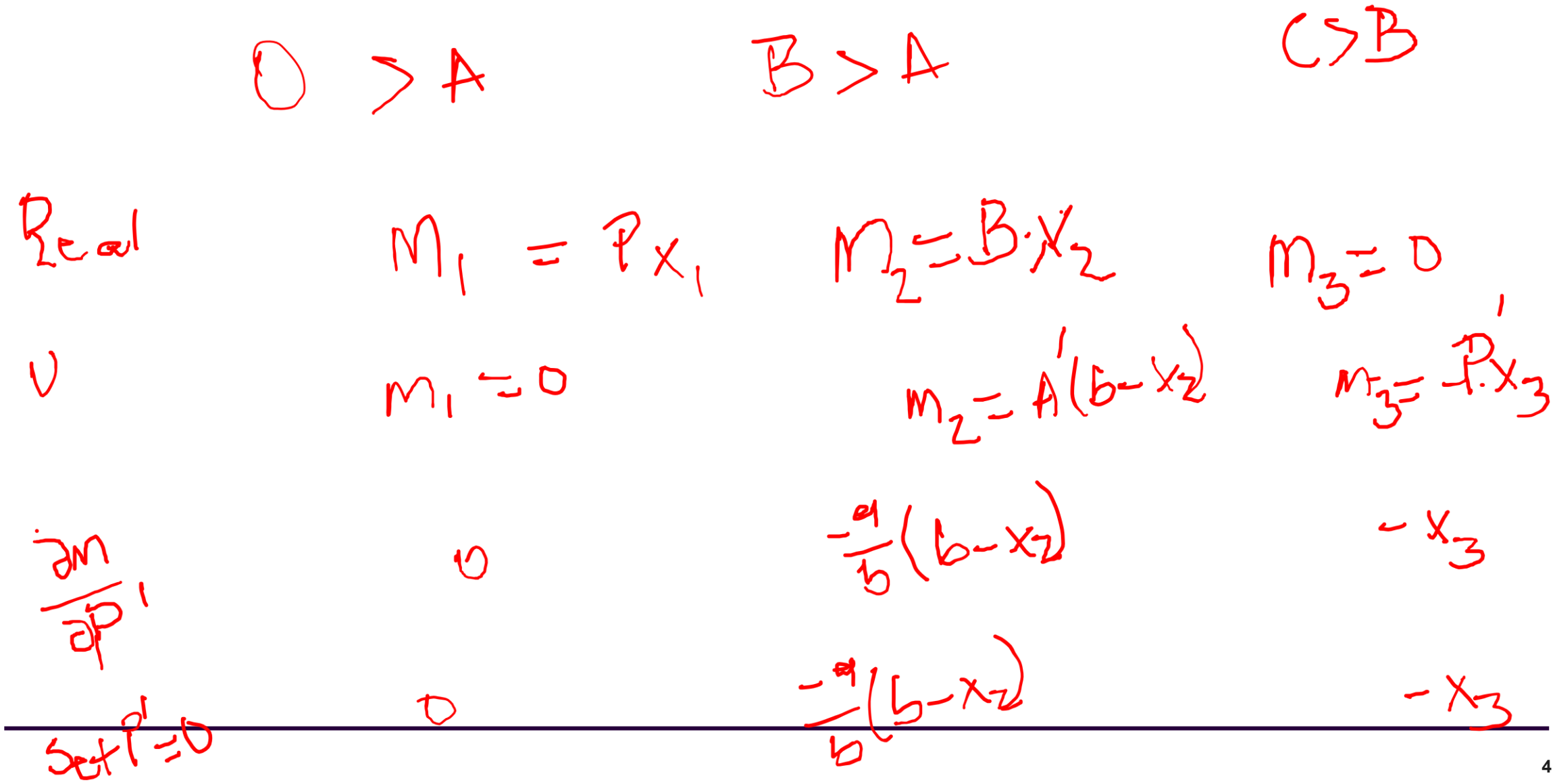
Solution to 14-91

$+\uparrow \Sigma F_y = 0 \qquad A' + B' - P' = 0 \qquad (1)$

$\circlearrowleft + \Sigma M_B = 0 \qquad A' \cdot b + P' \cdot a = 0 \qquad (2)$

$A' = \dfrac{-P' \cdot a}{b} \qquad B' = \dfrac{P'(a+b)}{b}$

Solution to 14-91



Solution to 14-91

$$D = \int_0^L \left(\frac{\partial M}{\partial P}\right)\frac{M}{EI}\,dx$$

$$\Delta C = \frac{1}{EI}\left[\int_0^a \left(\frac{d}{dP}M_1\right)\cdot M_1\,dx + \int_0^b \left(\frac{d}{dP}M_2\right)M_2\,dx_2 + \int_0^a \left(\frac{d}{dP}M_3\right)M_3\,dx_3\right]$$

$$\Delta C = \frac{1}{EI}\left[0 + -\frac{a}{b}(b-x_2)(B\cdot x_2)\,dx_2 + 0\right]$$

$$\Delta C = 10{,}71\ \text{mm}\ \downarrow$$